

What is claimed is:

1 1. A method for forming a bottle-shaped trench
2 comprising the steps of:
3 providing a substrate having a pad structure and at
4 least one trench therein;
5 forming a mask layer to fill the bottom of the trench;
6 etching the portion of the semiconductor substrate of
7 the trench which is not covered by the mask
8 layer; and
9 removing the mask layer to form the bottle-shaped
10 trench.

1 2. The method of claim 1, wherein the etching of the
2 semiconductor substrate to form a bottle-shaped trench
3 comprises the steps of:
4 filling de-ionized water in the trench; and
5 diffusing an etchant in the trench by means of the de-
6 ionized water, thereby etching the semiconductor
7 substrate not covered by the masking layer.

1 3. The method of claim 2, wherein the step of filling
2 the de-ionized water in the trench comprises: immersing the
3 semiconductor substrate in the de-ionized water.

4 4. The method of claim 2, wherein the step of
5 diffusing an etchant in the trench comprises: immersing the
6 semiconductor substrate in an etching solution containing
7 the $\text{NH}_4\text{OH}+\text{H}_2\text{O}$ etchant.

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1 5. The method of claim 1, wherein the semiconductor
2 substrate is etched using $\text{NH}_4\text{OH}+\text{H}_2\text{O}$ to form the bottle-
3 shaped trench.

1 6. The method of claim 1, wherein the pad structure
2 comprises a stacked oxide layer and a nitride layer.

1 7. The method of claim 1, wherein the masking
2 material is photoresist.

1 8. The method of claim 1, wherein the filling of the
2 mask layer in the trench comprises the steps of:

3 coating the pad structure with a masking material to
4 fill the trench; and

5 recessing the masking material to a predetermined
6 depth, thus forming a mask layer in the trench.

1 9. The method of claim 8, wherein the masking
2 material is removed with a solution comprising a mixture of
3 H_2SO_4 and Hydrogen Peroxide.

1 10. The method of claim 1, wherein the trench has a
2 sidewall with a collar oxide layer at the top of the trench,
3 and the semiconductor substrate unmasked by the collar oxide
4 layer is etched in the trench.

1 11. The method of claim 1, wherein the depth of the
2 mask layer is defined to about 600nm from the top of the
3 trench.